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# GREENHOUSE GAS CALCULATION METHODS

**Workshop Sustainability certification  
for biofuels and bio-energy**

**Brussels, January 29, 2009**

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**Sustainable Development and Innovation Management**



# Critics





# Critics and doubts: Can (1<sup>st</sup> generation) biofuels reduce GHG emissions?

- “Including GHG emissions from indirect land clearance can drastically reduce or even eliminate GHG benefits”  
*(Fargione et al 2008, Searchinger et al 2008)*
- “The N<sub>2</sub>O release from agro-biofuel production negates global warming reduction by replacing fossil fuels” *(Crutzen et al. 2008)*





## Are critics and doubts justified?

- These studies show negative GHG impacts for biomass production ....

### **HOWEVER**

- The selection of different parameters can change the results
- There is a nuance and variability of GHG balances due to the complexity of biomass energy systems (crop, region, energy carrier) and the sensitivity of a wide range of parameters





## An accurate GHG methodology is needed as the GHG balances have to be calculated for various purposes as:

- CDM (Kyoto Protocol)
- Joint Implementation (Kyoto Protocol)
- Recently: requirements on GHG performance biofuels (e.g. EU: 35% reduction compared to reference fuel)

Results GHG reduction performance – and reduction costs – are interesting for various stakeholder groups (investors, policy makers, certifying bodies)



# Initiatives in development GHG methodologies



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## - INTERNATIONAL ORGANIZATIONS (I) -

### IPCC

- IPCC Guidelines for National Greenhouse Gas Inventories for estimating national GHG inventories;
- IPCC guidelines for LULUCF;

### UNFCCC

- Specific methodologies developed for CDM projects. The same principles apply to JI methodologies;

### Global Bioenergy Partnership (GBEP)

- Task Force on the harmonization of methodologies for measuring GHG emission reductions from the use of biofuels.
- Development of a template + good practice guidance



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## - INTERNATIONAL ORGANIZATIONS (II) -

### International Organization for Standardization (ISO)

- ISO 14040 describes principles and framework for LCA.
- Member bodies (Brazil, Germany) propose new ISO work on “Sustainability criteria for biofuels”.

### European Committee for Standardization (CEN)

- Technical committee (CEN TC 383) on ‘Sustainably produced biomass for energy applications’ is established to promote standardization;
- One of the working groups focuses on the standardization of GHG methodologies > provide clarification on issues



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## - INTERNATIONAL ORGANIZATIONS (III) -

### UNEP

- Two main review studies of LCA / GHG emissions of biofuels
- Identification research gaps and future recommendations

### IEA Task 38

- Aims to demonstrate and promote the use of a standard GHG methodology;
- Published a number of reports, articles, case studies

### Roundtable on Sustainable Biofuels (RSB)

- Draft standard on principles and criteria for sustainable biofuels: Principle 3 on GHG balances;
- Aim: to establish an acceptable standard methodology for comparing GHG benefits of biofuels;



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## - NATIONAL GOVERNMENTS (I) -

### United Kingdom:

- Carbon reporting expected from obligated companies under the RTFO (Renewable Transport Fuels Obligation);
- Carbon methodology forms the foundation;
- Monthly reporting (administrative batch) of the net GHG savings of the biofuels;

General Information				Sustainability Information				Carbon Information	
Fuel type	Quantity of fuel (litres)	Biofuel Feedstock	Feedstock Origin	Standard	Env Level	Social Level	Land use on 30 Nov 2005	Carbon intensity incl LUC g CO <sub>2e</sub> / MJ	Accuracy level
Bioethanol	250,000	Wheat	UK	LEAF	QS	-	Cropland	61	2
Bioethanol	100,000	Wheat	France	GlobalGAP	-	-	Grassland	122	2
Bioethanol	250,000	Sugar beet	UK	ACCS	QS	-	Cropland	35	5
Bioethanol	1,000,000	Sugar cane	Brazil	Meta-Standard	RTFO	RTFO	Cropland	24	2
Bioethanol	500,000	Unknown	Unknown	Unknown	-	-	Unknown	61	0
Biodiesel	1,000,000	Oilseed rape	UK	ACCS	RTFO	RTFO	Cropland	55	2
Biodiesel	250,000	Oilseed rape	Unknown	Unknown	-	-	Unknown	55	2
Biodiesel	500,000	Palm oil	Malaysia	RSPO	QS	QS	Cropland	45	2
Biodiesel	500,000	Soy	Argentina	Basel	QS	QS	Grassland	177	2
Biodiesel	250,000	UCO	UK	By-product	QS	QS	By-product	13	2
Biomethane	150,000	Dry manure	UK	By-product	QS	QS	By-product	36	2

Source: [A. Berry 2008]

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## - NATIONAL GOVERNMENTS (II) -

### Netherlands:

- GHG methodology is developed and implemented in two calculation tools (for biofuels and for bio-electricity and heat)
- Two reports on technical specifications tools are published (can be downloaded);
- GHG calculation tools online, available for interested stakeholders;

### Germany:

- Biomass Sustainability Ordinance (BSO) requests a minimum CO<sub>2</sub> saving for biofuels;
- GHG methodology for biofuels developed;
- Methodology biofuels forms basis for development methodology for biomass for energy in 2009;



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## - NATIONAL GOVERNMENTS (III) -

### Belgium:

- Renewable obligation of 6% renewable electricity by 2010 in the frame of targeted green certificate systems
- Based upon avoided fossil CO<sub>2</sub> emissions in Wallonia and Brussels region;
- Calculated with defined formula. Reference: Combined cycle power plant firing natural gas;

### Switzerland:

- Tax exemption biofuels with 40% GWP reduction and <125% of overall environmental impacts (UBP) than the fossil reference system;
- Full LCA required
- Based on Ecoinvent methodology and tool;



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## - NATIONAL GOVERNMENTS (IV) -

### USA:

#### State Massachusetts:

- Tax exemption renewable fuels;
- Qualifying biofuels must show 50% GHG reduction compared to petroleum;
- Full LCA is required for biofuels including indirect emissions and land-use changes

#### State California:

- Low-Carbon Fuel Standard
- Protocols to measure carbon-intensity of fuels which includes full LCAs



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## - European Commission / Parliament / Council -

- 35% GHG emission reduction biofuels and other bioliquids compared to reference fuel;
- 35% reduction will increase to 50-60% by 2010;
- Ongoing: Fixed GHG methodology for liquid biofuels and methane (see also CEN initiative);
- Currently focus is on biofuels. Biomass for energy and heat will follow later in 2010;
- Approach must be followed by all individual EC countries;



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# Initiatives in development GHG methodologies - COMPANIES -

## SWAN label:

- Fuel, based on at least 1/3 (vol.%) renewable raw material, does not give rise to more than 50 g CO<sub>2</sub>eq per MJ of fuel.
- The applicant must document for a life-cycle perspective

## Electrabel/Laboralec:

- CO<sub>2</sub> balance of the supply chain including electricity use, fossil primary energy use and transport;
- Spreadsheet model used by stakeholders delivering feedstock, mainly wood pellets, for bioenergy;

*Also various models GHG analysis tools and databases exist (CO2Fix, TimberCam, GREET, SIMAPRO, ...)*





# Initiatives in development GHG methodologies

## OVERVIEW OF METHODOLOGIES

### (for European initiatives)

Initiative	Biomass included	Allocation matters	ILUC	LUC	Calculated N <sub>2</sub> O emissions	Default values
EC	Biofuels and bioliquids	By energy content for regulation	ILUC penalty under discussion	Formula soil carbon / default	(JEC 2007) in EU, IPCC outside EU	Conservative
UK-RTFO	Biofuels	Subtraction is 1 <sup>st</sup> choice	Conversion forest only	Calculated, monitoring	IPCC approach	Conservative
Germany	Biofuels, Bioenergy for heating and power to be included	Allocation by energy content (LHV)	In discussion, risk adder approach?	Formula soil carbon, IPCC	Included, IPCC when data limited	Conservative
Netherlands	Two tools: a) Biofuels and b) Bio-energy for heating and power	Allocation by energy content	Methodology proposed (monitoring)	Methodology based on IPCC	Included, IPCC when data limited	Conservative / typical / best practice
Wallonia (Belgium)	Main biomass sources for bioenergy for power	Not included	Not included	Not included	Not included	Provided by Wallonia government
Electrabel / Laborelec	Bioenergy for heating and power	Not included	Not included	Not included	Not included	Some data provided
Swan label (Nordic countries)	Biofuels	Subtraction is 1 <sup>st</sup> choice	Not mentioned	No negative balance is required	Included	Yes. Not for production
RSB (based on draft standard 2008)	Biofuels	Guidelines are under development	ILUC to be minimized. Under discussion.	Based on IPCC methodology and values	To be addressed	Criteria for acceptable default values under development



## Where do we stand now?

- The wide range of initiatives to actually try to set 'sustainability criteria' for a commodity is appreciable;
- This takes time (allow for learning);
- Concerns differ: focus on palm oil, soy bean, corn... wood, residues, biofuels, bioenergy;
- Global convergence, dialogue and deployment priority;
- Methodological issues, a.o. related to GHG balance and biodiversity, need to be resolved





## Some key methodological issues related to calculation of GHG balance:

1. Reference land-use (type, management system)
2. Indirect land-use
3. Allocation
4. Data input (specific data, default values)
5. Time scale issues
6. Uncertainties in methodology



# Selection reference land-use



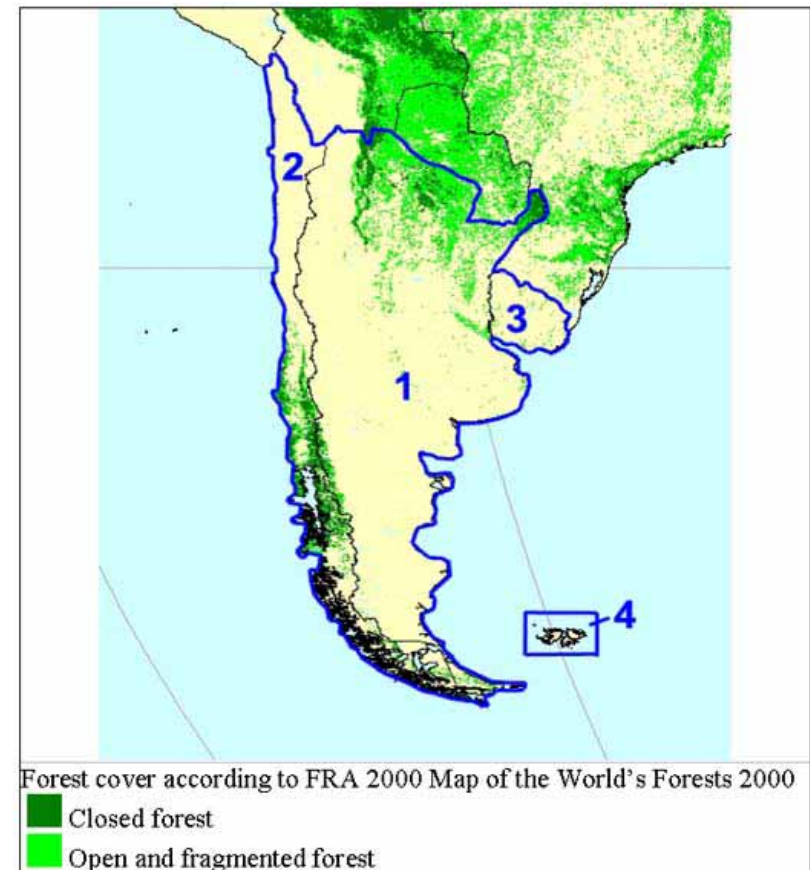
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Example: current GHG calculation tool NL for biofuels includes for chain 'soybean in Argentina':

- No LUC *or* Tropical Moist Rainforest

Land cover in Argentina:

- ≈ 19% Forest (not all tropical!!)
- 52%** Pasture land
- 10% agriculture-cultivated land
- 19% other land

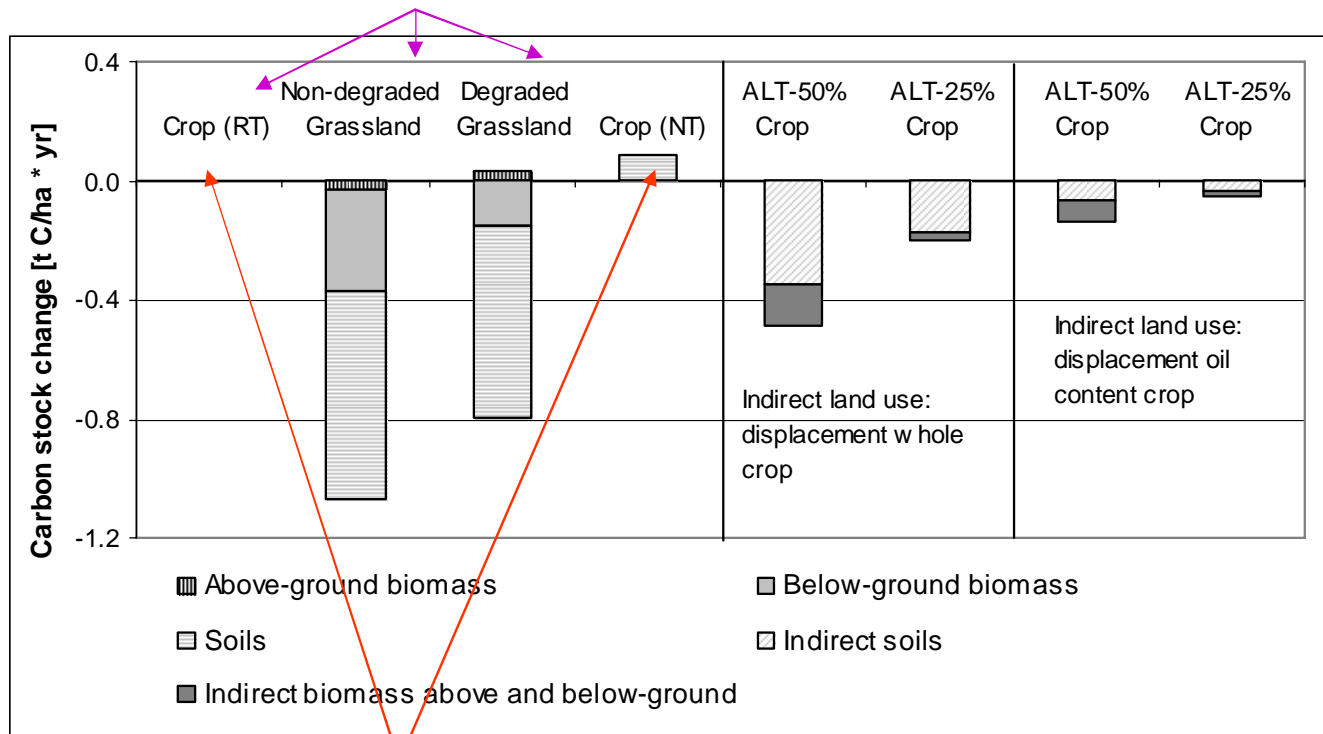


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# Case study for La Pampa in central Argentina for soybean and switchgrass production

Reference land-use is abandoned cropland or (non-)degraded grassland



Soybean management system: Reduced tillage (RT) or No tillage (NT)





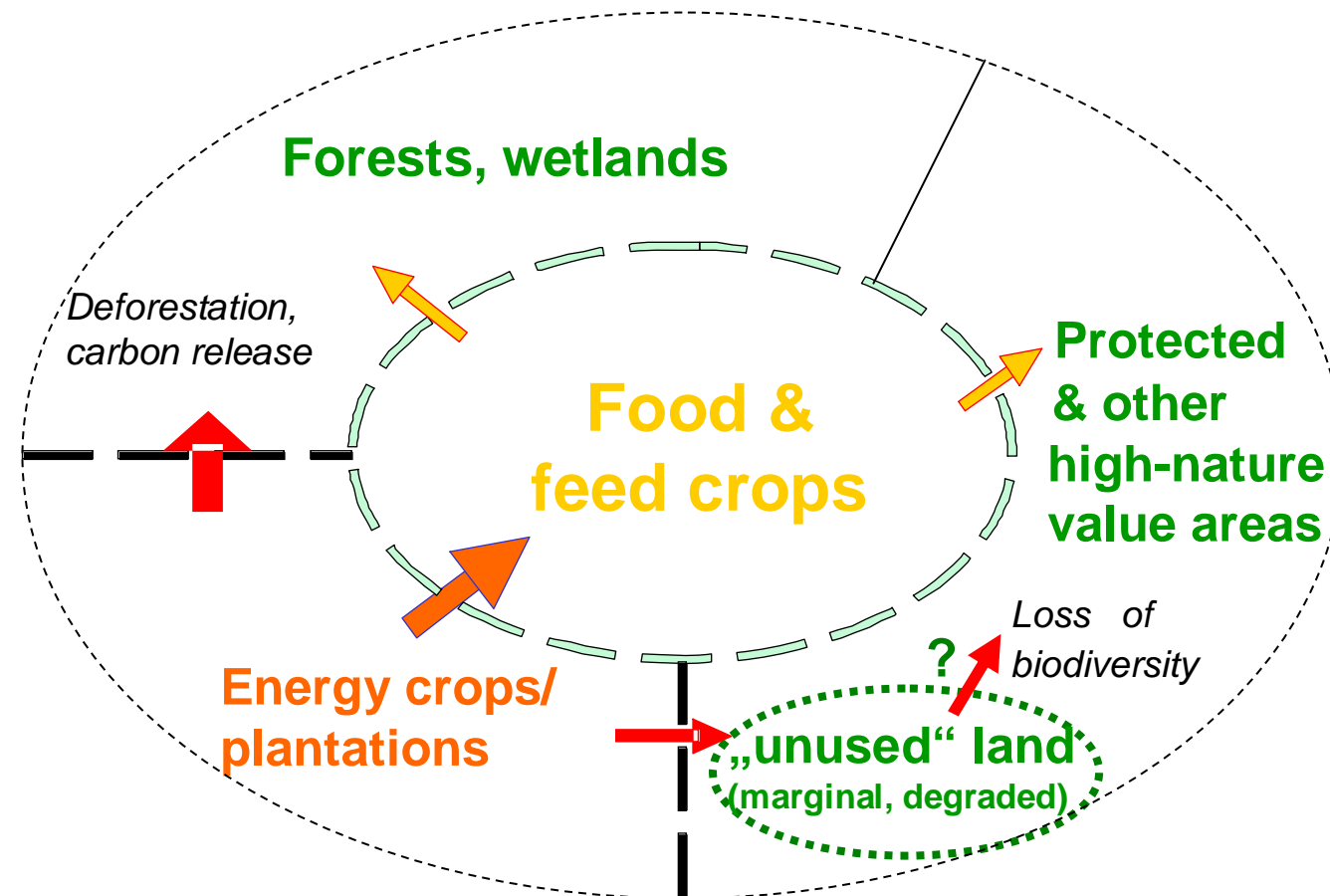
# Key issues for selection reference land-use

- Careful selection reference land-use and management system as they influence GHG balances;
- More specific data are needed to cover this wide range (region and crop specific);
- These options need to be available for users (in time);





# Indirect land use: displacement effects



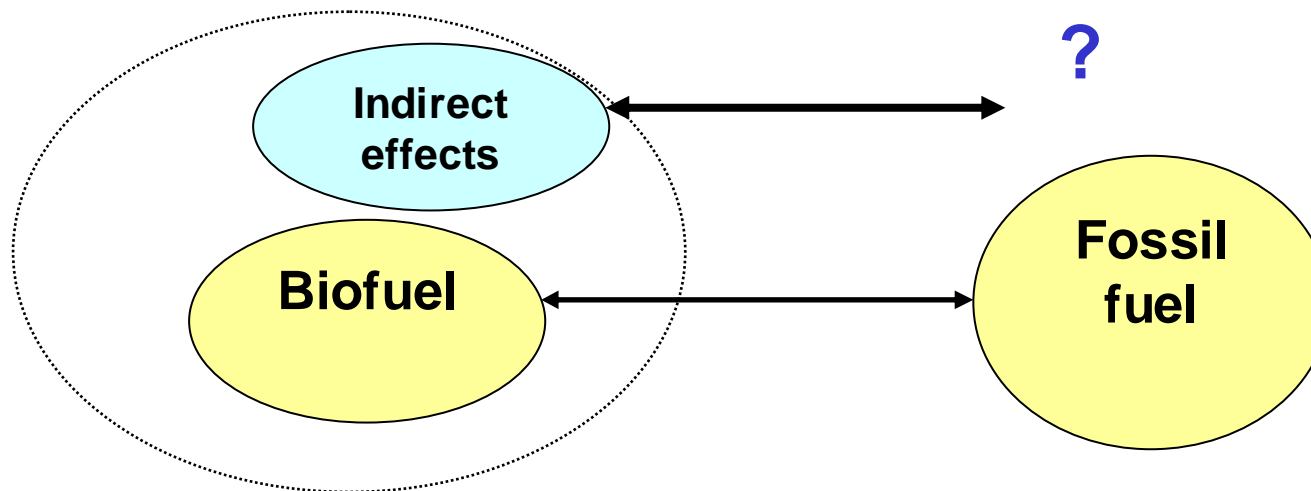
Source: based on Girard (GEF-STAP Biofuels Workshop, New Delhi 2005)





## GHG emissions from indirect land use (I)

- Generic problem of restricted system boundaries





## GHG emissions from indirect land use (II)

- All incremental land uses imply indirect effects;
- Which displacement; when and where?
- To whom can the displacement be attributed (many stakeholders)?
- And how much is due to bioenergy?





# GHG emissions from indirect land use: Political and analytical implications

- Which instruments to use?
- How to link macro-economic effects with field level?
- Partial certification systems do not help but may have spill over effects...
- Proposals: monitoring, ILUC approach





# ILUC approach

- Potential release of CO<sub>2</sub> from LUC caused by displacement is function of land used to produce agro products for exports
- Deterministic, describes average impacts;
- Uses average CO<sub>2</sub> emission factor per ha of displaced land;

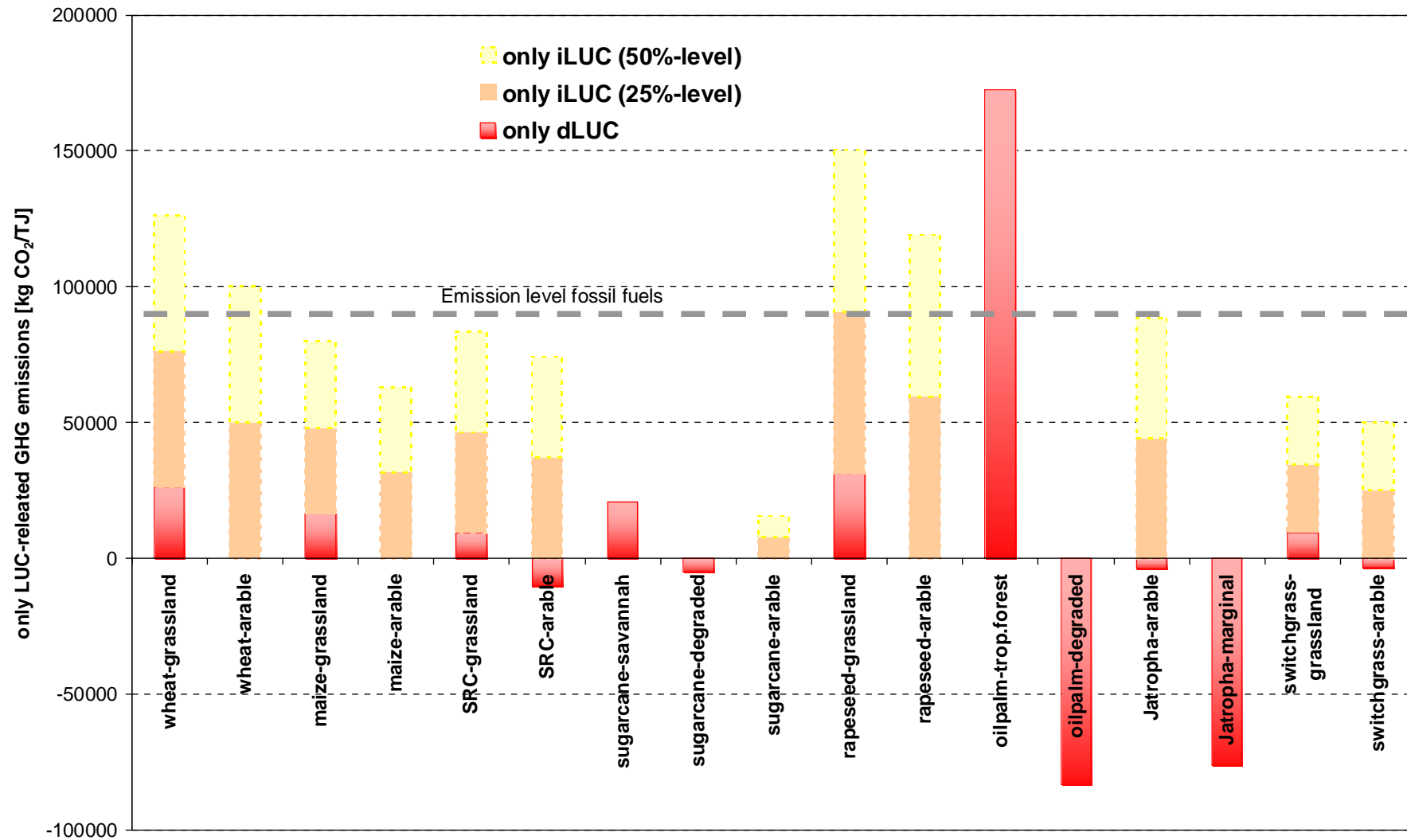
Example: Accounting for CO<sub>2</sub> from indirect LUC using the “iLUC factor“ for the GHG balance of biofuels\*

biofuel route, <b>life-cycle</b>	kg CO <sub>2eq</sub> /GJ <b>with iLUC factor</b>			relative to fossil diesel/gasoline,		
	including conversion/by-products, <b>without direct LUC</b>			including conversion/by-products		
	max	med	low	max	med	low
Rapeseed to FAME, EU	260	188	117	<b>201%</b>	<b>118%</b>	<b>35%</b>
palmoil to FAME, ID	84	64	45	-3%	-25%	-48%
soybean oil to FAME, Brazil	101	76	51	<b>17%</b>	-12%	-41%
sugarcane to EtOH, Brazil	48	42	36	-44%	-52%	-59%
maize to EtOH, US	129	101	72	<b>50%</b>	<b>17%</b>	-16%
wheat to EtOH, EU	144	110	77	<b>67%</b>	<b>28%</b>	-11%
SRC/SG to BtL, EU	109	75	42	<b>26%</b>	-13%	-51%
SRC/SG to BtL, Brazil, tropical	34	25	17	-61%	-71%	-80%
SRC/SG to BtL, Brazil, savanna	59	42	25	-32%	-51%	-71%





# Direct and indirect GHG from LUC





## Allocation issues (I)

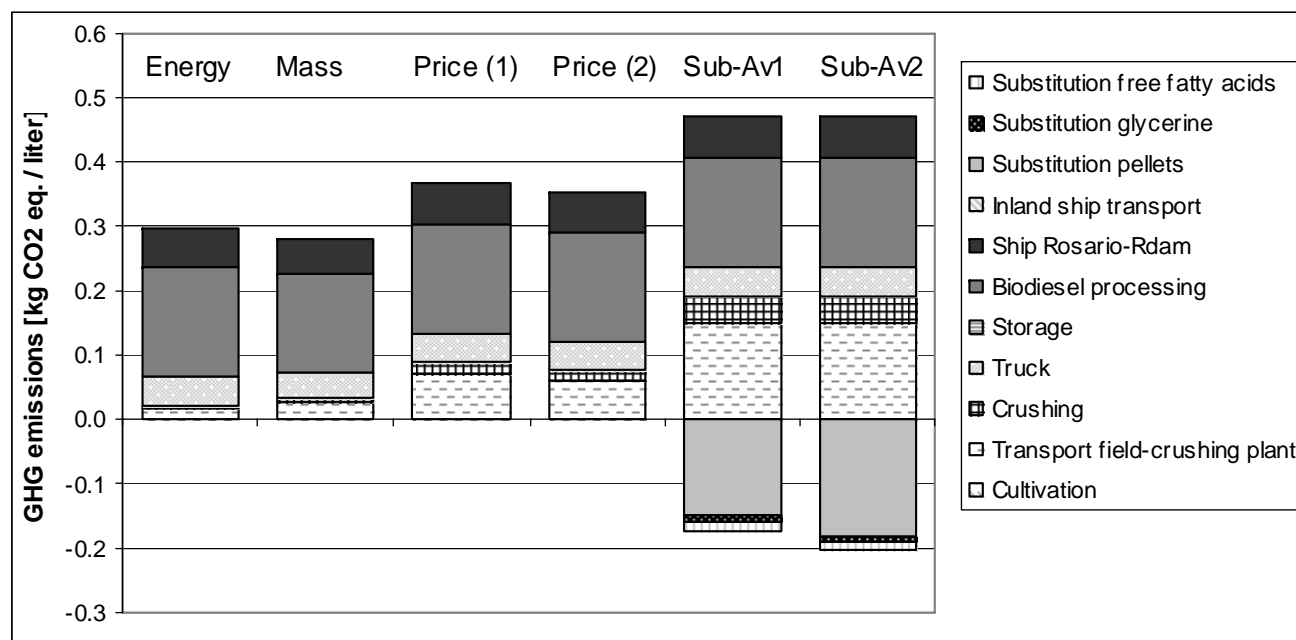
- Options: Extension system boundary substitution or allocation (based on physical relationships or market value)
- There is no single approach which is appropriate for all circumstances;
- EU (and its individual countries) opt for allocation based on energy content for regulation purposes



# Allocation issues (II)



- Allocation based on physical relationships create less insecurity due to different input data
- Insight in price and substitution input data essential when using this approach



Source: Van Dam et al., 2009 (forthcoming)

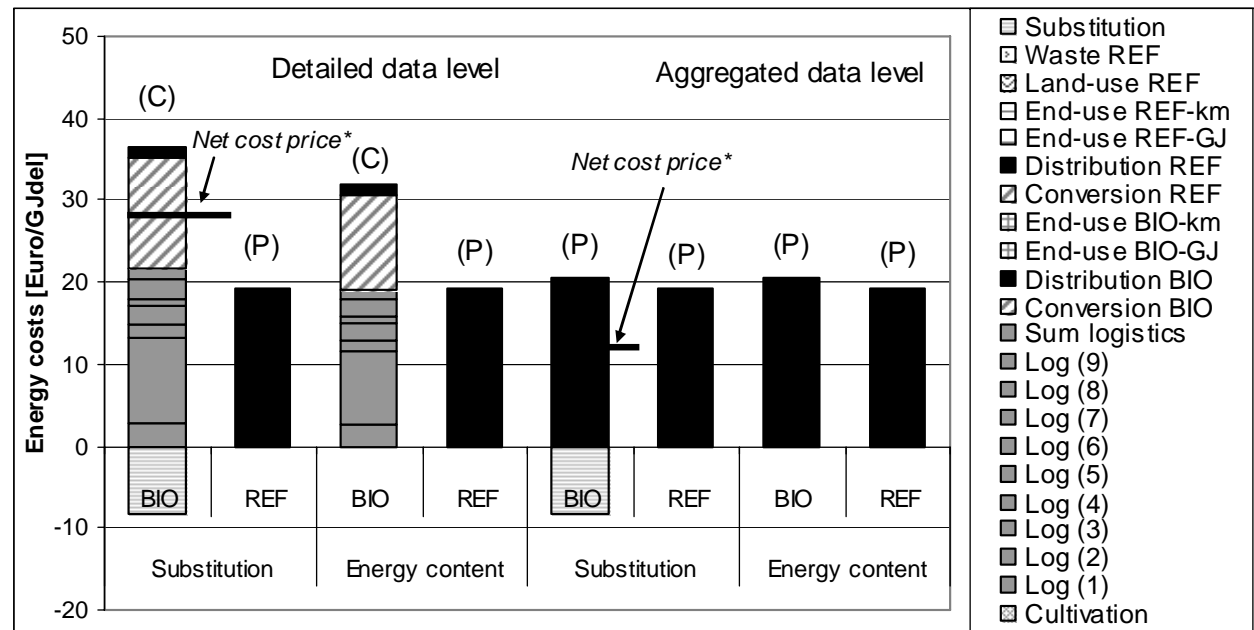




# Data input: specific data and default values

- Choice between site specific data (when available) and aggregated data
- Level of data collection, e.g. per transport step (truck, train, ship) or for complete transportation step)
- When limited to default values: Conservative, best practice?

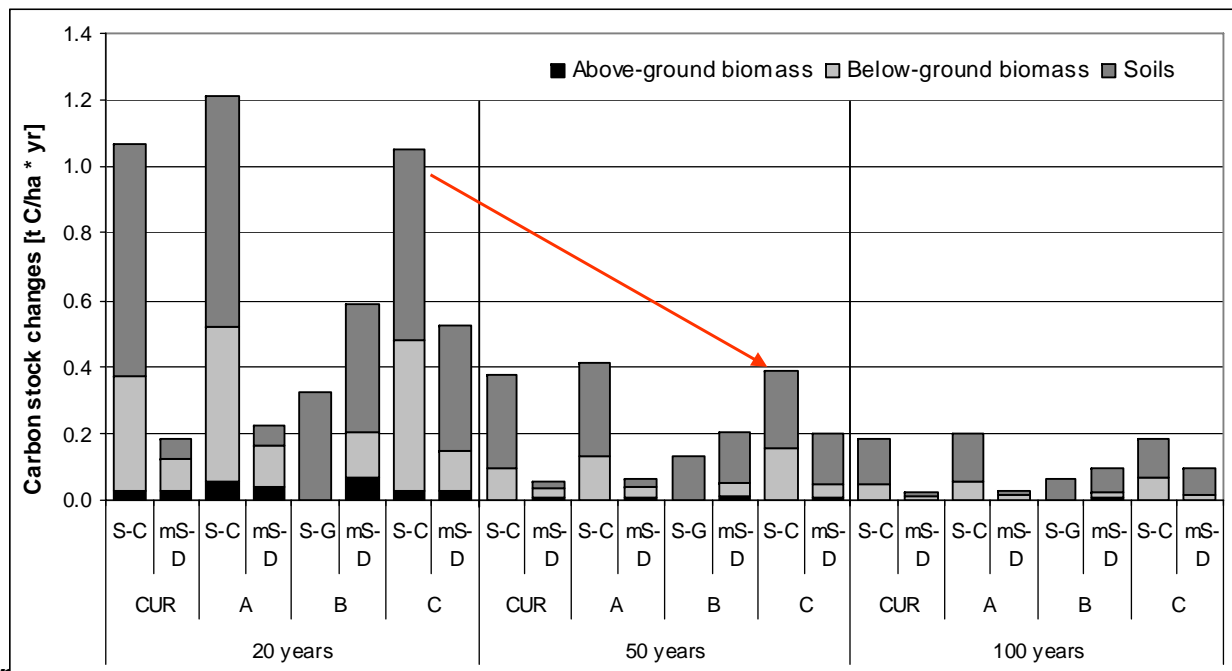
Example influence of detailed / aggregated data level on cost results for Dutch-Canadian case study.



# Time scale issues



- Technology improvement over time have influence on GHG and cost results > Selection of technology and system important
- Selection of accounting period has influence on results carbon stock changes



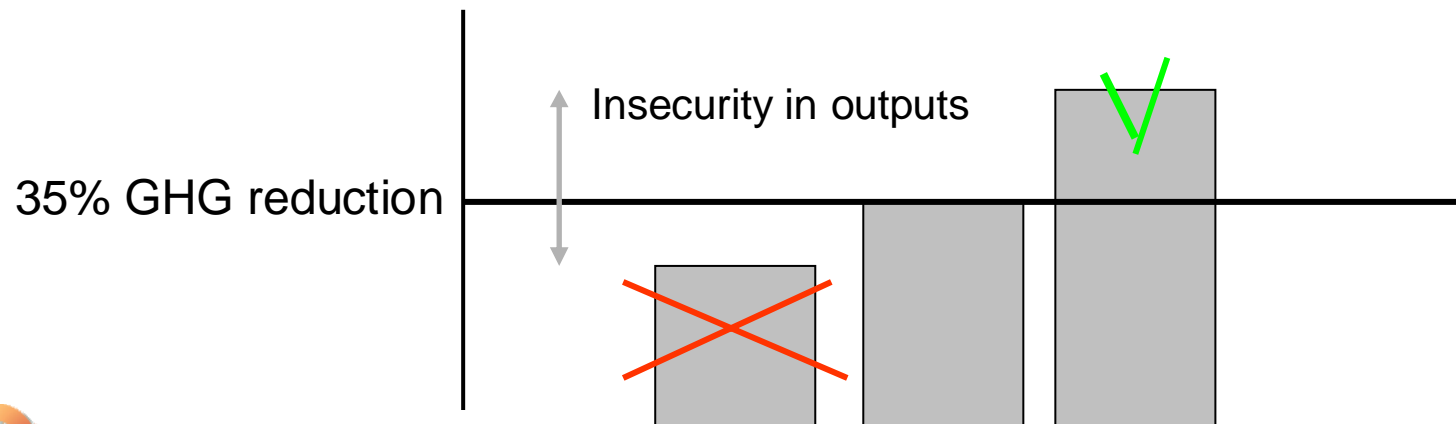
Source: Van Dam et al., 2009 (forthcoming)





## Uncertainties in IPCC methodology

- Case study Argentina (*Hilbert 2008*): variation of 15% in results GHG balances when using IPCC methodology
- Case study Palm Plantations in Indonesia (*Wicke et al 2009*): Range of N<sub>2</sub>O emission factor from managed soils (IPCC) can increase or decrease the overall GHG balances by more than 10%





## Conclusions (I)

- Still a lot of insecurities in methodological choices and data input;
- In this context, site specific, disaggregated analyses are preferable; BUT regulation requires default data;
- Development of a standardized GHG methodology is a process (learning-by-doing) and its development takes time;





## Conclusions (II)

- ....At the same time there is an urgent need to safeguard the GHG balance of biofuels and biomass for bioenergy and power;
- Unused degraded lands, residues, waste preferred for avoided a.o. risk on leakage.





## To limit the uncertainties, there is a strong need for:

- International agreement on methodology and data input (default values);
- Data collection and the development of consistent databases (especially for developing countries);
- Improved transparency, accuracy and consistency in LCA studies;





## Possible risks when these needs are not fulfilled:

- Possibility to 'cheat' with results;
- Lack of credibility for biomass certification;
- Trade barriers (results cannot be compared or are not provided / available, proliferation of standards)

**Thus, concerted and joint action is urgently needed!**





# THANK YOU FOR YOUR ATTENTION!

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